

**CLAIMS**

What is claimed is:

1. A production process comprising halogenating an alkyl reactant with a halogenating agent within a reactor to form a halogenated compound,  
5 wherein at least one interior sidewall of the reactor comprises glass.
2. The production process of claim 1 wherein the sidewall further comprises hastelloy®.
3. The production process of claim 1 wherein the alkyl reactant comprises an olefin.
- 10 4. The production process of claim 3 wherein the alkyl reactant comprises a fluoro-olefin.
5. The production process of claim 4 wherein the alkyl reactant comprises hexafluoropropene.
- 15 6. The production process of claim 1 wherein the halogenating agent comprises a salt and a diatomic halogen.
7. The production process of claim 6 wherein the halogenating agent comprises KF and I<sub>2</sub>.
8. The production process of claim 1 wherein:  
the alkyl reactant comprises hexafluoropropene;  
20 the halogenating agent comprises KF and I<sub>2</sub>; and  
the halogenated compound comprises 2-iodoheptafluoropropane.
9. The production process of claim 1 wherein the halogenating comprises:  
providing the halogenating agent and a reactant media to the reactor, the  
halogenating agent and the reactant media forming a first mixture within the reactor;  
25 after forming the first mixture, providing the alkyl reactant to the reactor, the alkyl  
reactant, the halogenating agent, and the reactant media forming a second mixture within  
the reactor; and  
reacting the alkyl reactant with the halogenating agent within the second mixture to  
form the halogenated compound.
- 30 10. The production process of claim 9 wherein at least the reactant media of the  
second mixture is in the liquid phase during the reacting.

11. The production process of claim 9 wherein the reacting comprises agitating the second mixture.

12. The production process of claim 9 wherein the reacting comprises heating the second mixture.

5 13. The production process of claim 9 wherein:  
the halogenating agent comprises KF and I<sub>2</sub>;  
the reactant media comprises acetonitrile;  
the alkyl reactant comprises hexafluoropropene; and  
the reacting comprises heating at least a portion of the second mixture to at least  
10 about 100 °C.

14. The production process of claim 9 wherein:  
the halogenating agent comprises KF and I<sub>2</sub>;  
the reactant media comprises acetonitrile;  
the alkyl reactant comprises hexafluoropropene; and  
15 the reacting comprises maintaining a pressure of at least 446 kPa within the reactor during the reacting.

15. The production process of claim 1 further comprising removing the halogenated compound from the reactor.

20 16. The production process of claim 15 wherein:  
the reactor further comprises a condenser; and  
the removing comprises:  
transforming at least a portion of the halogenated compound within the  
reactor into a gas;  
transferring the gas to the condenser;  
25 returning the gas into a liquid within the condenser; and  
removing the liquid from the condenser.

17. The production process of claim 16 wherein:  
the halogenating agent comprises KF, I<sub>2</sub>, and a reactant media, the reactant media comprising acetonitrile;  
the alkyl reactant comprises hexafluoropropene;  
5 the halogenated compound comprises 2-iodoheptafluoropropane;  
the transforming comprises heating at least a portion of the 2-iodoheptafluoropropane to at least about 40 °C; and  
the removing comprises removing 2-iodoheptafluoropropane from the condenser.

18. A production system comprising a reactor coupled to alkyl reactant,  
10 halogenating agent, and halogenated compound reservoirs and configured to received an alkyl reactant and a halogenating agent from the reactant and agent reservoirs and provide a halogenated compound to the halogenated compound reservoir, the reactor comprising at least one interior sidewall, wherein the interior sidewall comprises glass.

19. The production system of claim 18 further comprising a reactant media  
15 reservoir coupled to the reactor, wherein the reactor is further configured to receive a reactant media from the reactant media reservoir.

20. The production system of claim 18 wherein:  
the alkyl reactant comprises hexafluoropropene;  
the halogenating agent comprises KF and I<sub>2</sub>;  
20 the reactant media comprises acetonitrile; and  
the halogenated compound comprises 2-iodoheptafluoropropane.

21. The production system of claim 20 wherein the reactor is further configured to form a first mixture comprising the KF, I<sub>2</sub>, and acetonitrile prior to receiving the hexafluoropropene.

22. The production system of claim 18 further comprising a condenser configured  
25 to receive at least a portion of the contents of the reactor and provide the halogenated compound to the halogenated compound reservoir.

23. The production system of claim 22 wherein the portion comprises the halogenated compound.

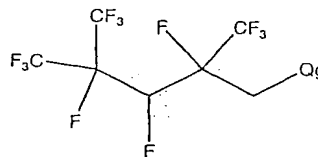
24. The production system of claim 23 wherein:  
the alkyl reactant comprises hexafluoropropene;  
the halogenating agent comprises KF and I<sub>2</sub>; and  
30 the halogenated compound comprises 2-iodoheptafluoropropane.

25. A composition comprising  $R_F-Q_g$ , wherein  $R_F$  comprises at least three  $-CF_3$  groups and  $Q_g$  is not a proton, methyl group, or methylene group.

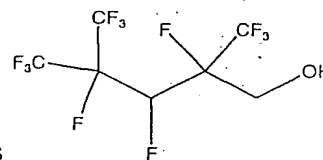
26. The composition of claim 25 wherein  $Q_g$  comprises one more of a halogen, a hydroxyl, a cyano, an acetate, an allyl, an epoxide, an acrylic ester, an ether, a sulfate, a thiol, a phosphate, and an amine.

27. The composition of claim 25 wherein  $R_F$  comprises at least one  $(CF_3)_2CF$ -group.

28. The composition of claim 25 wherein  $R_F$  comprises at least two  $(CF_3)_2CF$ -groups.

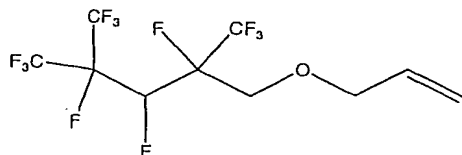


29. The composition of claim 25 wherein  $R_F-Q_g$  is

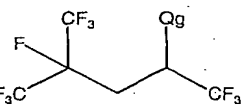


30. The composition of claim 29 wherein  $R_F-Q_g$  is

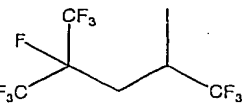
31. The composition of claim 25 wherein  $R_F-Q_g$  is



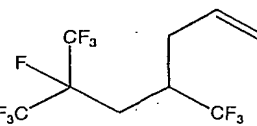
32. The composition of claim 25 wherein  $R_F-Q_g$  is



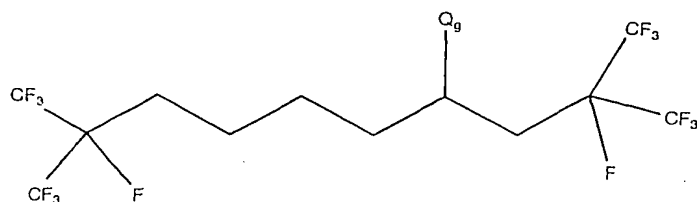
33. The composition of claim 25 wherein  $R_F-Q_g$  is



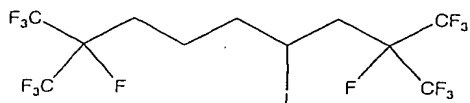
34. The composition of claim 25 wherein  $R_F-Q_g$  is



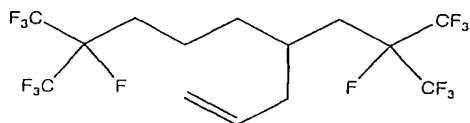
35. The composition of claim 25 wherein  $R_F-Q_g$  is



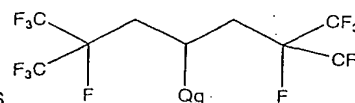
36. The composition of claim 25 wherein  $R_F-Q_g$  is



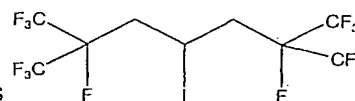
5 37. The composition of claim 25 wherein  $R_F-Q_g$  is



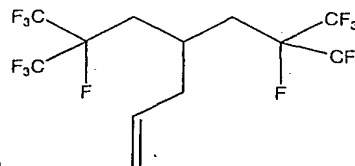
38. The composition of claim 25 wherein  $R_F-Q_g$  is



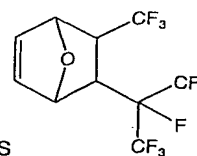
39. The composition of claim 25 wherein  $R_F-Q_g$  is



40. The composition of claim 25 wherein  $R_F-Q_g$  is



10 41. The composition of claim 25 wherein the  $R_F-Q_g$  comprises

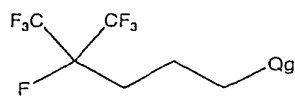


42. A composition comprising  $R_F-Q_g$ , wherein:

$R_F$  comprises at least two  $-CF_3$  groups and at least two  $-CH_2-$  groups; and  
 $Q_g$  is not a proton, methyl group or methylene group.

15 43. The composition of claim 42 wherein  $Q_g$  comprises one or more of a halogen, a hydroxyl, a cyano, an acetate, an allyl, an epoxide, an acrylic ester, an ether, a sulfate, a thiol, a phosphate, and an amine.

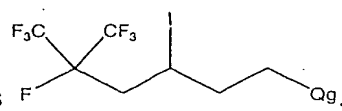
44. The composition of claim 42 wherein  $R_F$  comprises at least one  $(CF_3)_2CF$ -group.

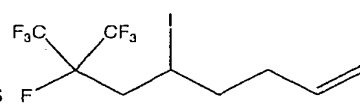
45. The composition of claim 42 wherein  $R_F-Q_g$  is 

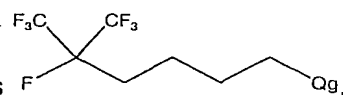
46. The composition of claim 42 wherein  $R_F-Q_g$  is 

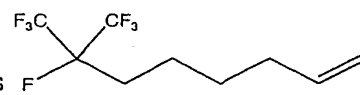
47. The composition of claim 42 wherein  $R_F-Q_g$  is 

48. The composition of claim 42 wherein  $R_F-Q_g$  is 

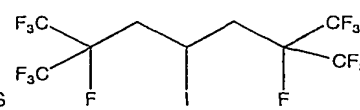
49. The composition of claim 42 wherein  $R_F-Q_g$  is 

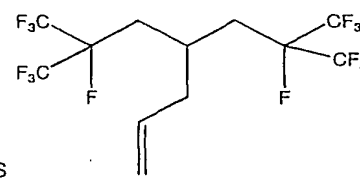
50. The composition of claim 42 wherein  $R_F-Q_g$  is 

51. The composition of claim 42 wherein  $R_F-Q_g$  is 

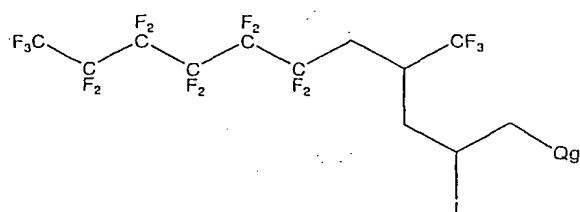
52. The composition of claim 42 wherein  $R_F-Q_g$  is 

53. The composition of claim 42 wherein  $R_F-Q_g$  is 

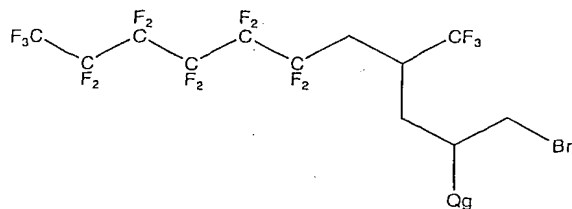
54. The composition of claim 42 wherein  $R_F-Q_g$  is 

55. The composition of claim 42 wherein  $R_F-Q_g$  is 

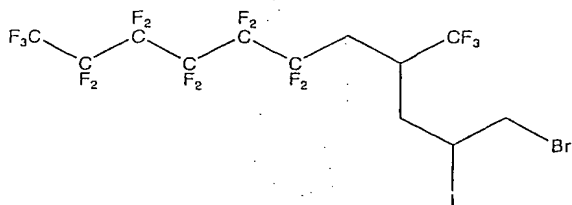
56. The composition of claim 42 wherein  $R_F-Q_g$  is



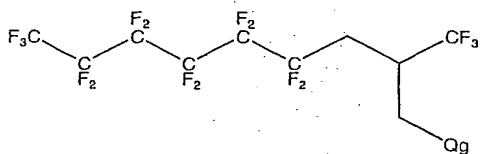
57. The composition of claim 42 wherein  $R_F-Q_g$  is



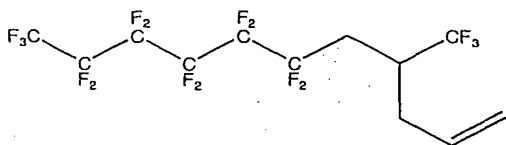
58. The composition of claim 42 wherein  $R_F-Q_g$  is



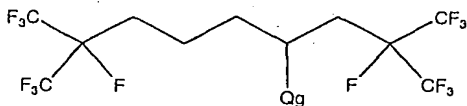
59. The composition of claim 42 wherein  $R_F-Q_g$  is



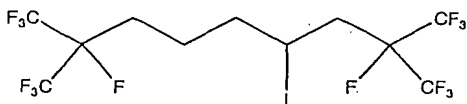
60. The composition of claim 42 wherein  $R_F-Q_g$  is



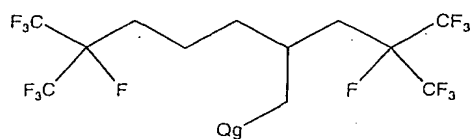
61. The composition of claim 42 wherein  $R_F-Q_g$  is



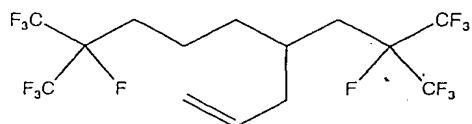
62. The composition of claim 42 wherein  $R_F-Q_g$  is



63. The composition of claim 42 wherein  $R_F-Q_g$  is

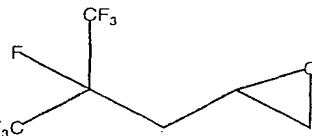


64. The composition of claim 42 wherein  $R_F-Q_g$  is



5 65. A composition comprising  $R_F-Q_g$ , wherein  $R_F$  comprises at least two  $-CF_3$  groups and  $Q_g$  comprises an epoxide group.

66. The composition of claim 65 wherein  $R_F-Q_g$  is



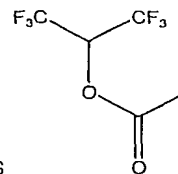
67. A composition comprising  $R_F-Q_g$ , wherein  $R_F$  comprises at least two  $-CF_3$  groups and  $Q_g$  comprises an ester group.

10 68. The composition of claim 67 wherein the ester group is unsaturated.

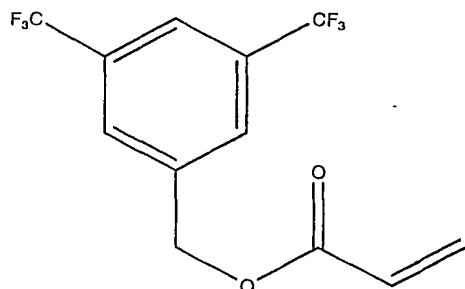
69. The composition of claim 67 wherein the ester group is a methyl ester group.

70. The composition of claim 67 wherein the ester group is an ethyl ester group.

71. The composition of claim 67 wherein  $R_F-Q_g$  is



72. The composition of claim 67 wherein  $R_F-Q_g$  is





73. A composition comprising  $R_F-Q_g$ , wherein:

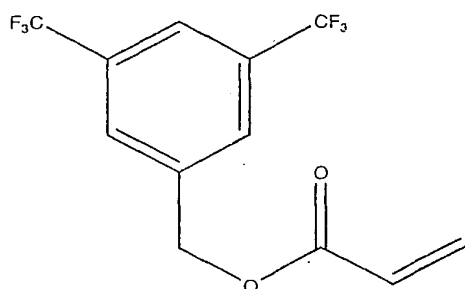
$R_F$  comprises at least two  $-CF_3$  groups and a cyclic group; and

$Q_g$  is not a proton, methyl group, or methylene group.

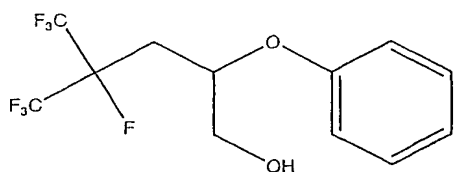
74. The composition of claim 73 wherein  $Q_g$  comprises one or more of a halogen,

5 a hydroxyl, a cyano, an acetate, an allyl, an epoxide, an acrylic ester, an ether, a sulfate, a thiol, a phosphate, and an amine.

75. The composition of claim 73 wherein  $R_F-Q_g$  is

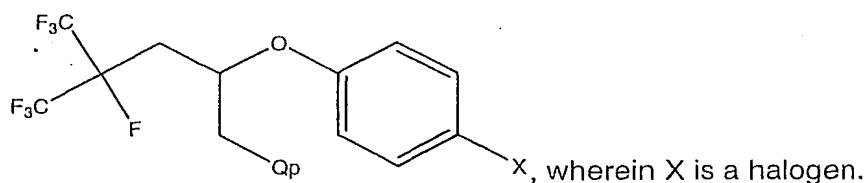


76. The composition of claim 73 wherein  $R_F-Q_g$  is

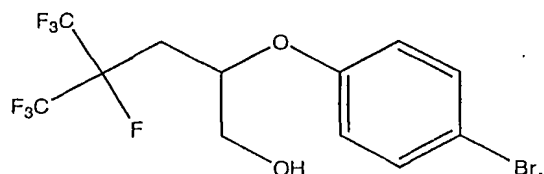


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77. The composition of claim 73 wherein  $R_F-Q_g$  is



78. The composition of claim 73 wherein  $R_F-Q_g$  is



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79. A production process comprising reacting a halogenated compound with an allyl-comprising compound in the presence of water to form a halogenated intermediate.

80. The production process of claim 79 wherein the halogenated compound, the allyl-comprising compound, and the water are comprised by an aqueous solution, the solution further comprising an aqueous salt solution.

81. The production process of claim 80 wherein the aqueous salt solution comprises Na.

82. The production process of claim 81 wherein the aqueous salt solution comprises  $\text{Na}_2\text{S}_2\text{O}_5$ .

5 83. The production process of claim 79 wherein the halogenated compound comprises at least two  $-\text{CF}_3$  groups.

84. The production process of claim 83 wherein the halogenated compound comprises at least one  $(\text{CF}_3)_2\text{CF}-$  group.

10 85. The production process of claim 79 wherein the halogenated compound comprises at least two  $-\text{CF}_3$  groups and a halogen other than fluorine.

86. The production process of claim 79 wherein the halogenated compound comprises 2-iodoheptafluoropropane.

87. The production process of claim 79 wherein the allyl-comprising compound comprises an ester.

15 88. The production process of claim 87 wherein the allyl-comprising compound comprises allyl acetate.

89. The production process of claim 79 wherein the allyl-comprising compound comprises an alcohol.

20 90. The production process of claim 89 wherein the allyl-comprising compound comprises allyl alcohol.

91. The production process of claim 79 wherein the halogenated intermediate comprises at least two  $-\text{CF}_3$  groups.

92. The production process of claim 91 wherein the halogenated intermediate comprises at least one  $(\text{CF}_3)_2\text{CF}-$  group.

25 93. The production process of claim 79 wherein the halogenated intermediate comprises at least two  $-\text{CF}_3$  groups and a halogen other than fluorine.

94. The production process of claim 79 wherein the halogenated intermediate comprises an ester group.

95. The production process of claim 94 wherein the halogenated intermediate comprises an acetate.

96. The production process of claim 79 wherein:  
the halogenated compound comprises 2-iodoheptafluoropropane;  
the allyl-comprising compound comprises allyl acetate;  
the aqueous solution further comprises  $\text{Na}_2\text{S}_2\text{O}_5$ ; and  
the halogenated intermediate comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentyl acetate.

97. The production process of claim 96 wherein the reacting comprises heating the aqueous solution to at least 80 °C.

98. The production process of claim 79 wherein the halogenated intermediate comprises an alcohol.

99. The production process of claim 98 wherein:  
the halogenated compound comprises 2-iodoheptafluoropropane;  
the allyl-comprising compound comprises allyl alcohol;  
the aqueous solution further comprises  $\text{Na}_2\text{S}_2\text{O}_5$ ; and  
the halogenated intermediate comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentan-1-ol.

100. The production process of claim 99 wherein the reacting comprises heating the aqueous solution to at least 90 °C.

101. The production process of claim 79 further comprising reacting the halogenated compound with the allyl-comprising compound in the presence of an initiator.

102. The production process of claim 101 wherein the initiator comprises azobisisobutylnitrile.

103. The production process of claim 79 further comprising unsaturating a portion of the halogenated intermediate to form a halogenated olefin.

104. The production process of claim 103 wherein the unsaturating comprises exposing the halogenated intermediate to a reducing agent.

105. The production process of claim 104 wherein the reducing agent comprises Zn.

106. The production process of claim 104 wherein the reducing agent comprises a first mixture comprising Zn and diethylene glycol.

107. The production process of claim 106 wherein:

the halogenated intermediate comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentyl acetate; and

the halogenated olefin comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)pent-1-ene.

108. The production process of claim 107 wherein the unsaturating comprises:

forming a second mixture comprising the 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentyl acetate and the first mixture; and

heating the second mixture to at least 120 °C.

109. The production process of claim 106 wherein:

the halogenated intermediate comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentan-1-ol; and

the halogenated olefin comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)pent-1-ene.

110. The production process of claim 107 wherein the unsaturating comprises:

forming a second mixture comprising the 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentan-1-ol and the first mixture; and

heating the second mixture to at least 120 °C.

111. The production process of claim 104 wherein the reducing agent comprises

pyridine.

112. The production process of claim 104 wherein the reducing agent comprises a mixture comprising  $\text{POCl}_3$  and pyridine.

113. The production process of claim 104 wherein:

the halogenated intermediate comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentan-1-ol; and

the halogenated olefin comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)pent-1-ene.

114. The production process of claim 113 wherein the unsaturating comprises:

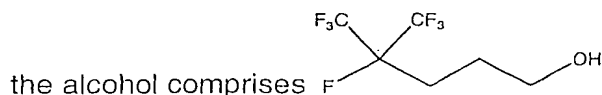
forming a mixture comprising the 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentan-1-ol and pyridine; and

exposing the first mixture to  $\text{POCl}_3$  while maintaining a temperature of the first mixture from about 0 °C to about 5 °C.

115. The production process of claim 79 further comprising dehalogenating a portion of the halogenated intermediate to form an alcohol.

116. The production process of claim 115 wherein the dehalogenating comprises exposing the intermediate to tributyltin hydride.

5 117. The production process of claim 115 wherein:  
the halogenated intermediate comprises 4,5,5,5-tetrafluoro-4-(trifluoromethyl)-2-iodopentan-1-ol; and



10 118. A production process comprising reacting an alcohol with a halogenated olefin to form an allyl-ether compound, wherein the alcohol comprises at least two  $-CF_3$  groups.

119. The production process of claim 118 wherein the alcohol comprises at least one  $(CF_3)_2CF-$  group.

15 120. The production process of claim 118 wherein the alcohol comprises at least three  $-CF_3$  groups.

121. The production process of claim 118 further comprising preparing the alcohol, wherein the preparing comprises:

providing at least two olefins, wherein each of the two olefins comprises at least one  $-CF_3$  group;

20 conjugating the two olefins to form an olefin intermediate, wherein the olefin intermediate comprises the  $-CF_3$  groups of the two olefins; and  
forming the alcohol from the olefin intermediate.

122. The production process of claim 121 wherein:

both the two olefins comprise perfluoroprop-1-ene;

25 the olefin intermediate comprises 1,2,3,4,4,4-heptafluoro-3-(trifluoromethyl)but-1-ene; and

the alcohol comprises 1,2,3,4,4,4-heptafluoro-2,4-bis-(trifluoromethyl)pentane-1-ol.

30 123. The production process of claim 122 wherein the conjugating comprises exposing the two olefins to one another in the presence of a mixture comprising KF, 18 crown 6, and methylene chloride.

124. The production process of claim 123 wherein the forming the alcohol from the olefin intermediate comprises reacting the olefin intermediate with methanol in the presence of a peroxide.

125. The production process of claim 124 wherein the peroxide comprises t-butyl peroxide.

126. The production process of claim 118 wherein the halogenated olefin comprises at least one halogen other than fluorine.

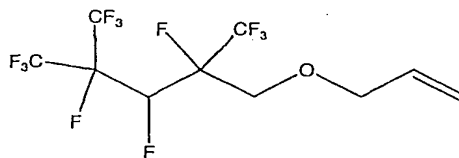
127. The production process of claim 126 wherein the halogen comprises bromine.

128. The production process of claim 126 wherein the allyl-ether compound comprises at least two  $-\text{CF}_3$  groups.

129. The production process of claim 128 wherein the allyl-ether compound comprises at least one  $(\text{CF}_3)_2\text{CF}-$  group.

130. The production process of claim 126 wherein the allyl-ether compound comprises at least three  $-\text{CF}_3$  groups.

131. The production process of claim 126 wherein:  
the alcohol comprises 1,2,3,4,4-heptafluoro-2,4-bis-(trifluoromethyl)pentane-1-ol;  
the halogenated olefin comprises 3-bromoprop-1-ene; and



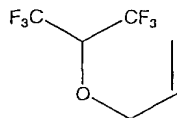
132. The production process of claim 131 wherein the reacting comprises exposing the alcohol to the olefin in the presence of a basic solution.

133. The production process of claim 132 wherein the basic solution comprises KOH.

134. The production process of claim 131 wherein the reacting comprises:  
preparing a mixture comprising the alcohol, the halogenated olefin, and a reactant media; and  
adding a basic solution to the mixture while maintaining a temperature of the mixture below at least 10 °C.

135. The production process of claim 134 wherein the reactant media comprises tetrabutylammonium hydrogen sulfate.

136. The production process of claim 126 wherein:  
the alcohol comprises 1,1,1,3,3,3-hexafluoropropan-2-ol;  
the olefin comprises 3-bromoprop-1-ene; and



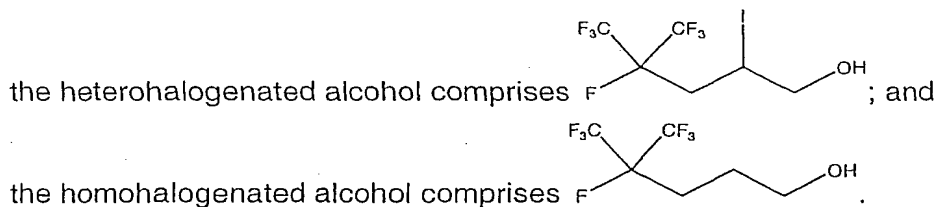
the allyl-ether compound comprises

137. A production process comprising dehalogenating a portion of a heterohalogenated alcohol to form a homohalogenated alcohol, wherein the heterohalogenated alcohol comprises at least two  $-CF_3$  groups and at least one halogen other than fluorine.

138. The production process of claim 137 wherein the dehalogenating comprises removing the halogen.

139. The production process of claim 137 wherein the heterohalogenated alcohol comprises at least one  $(CF_3)_2CF-$  group.

140. The production process of claim 137 wherein:

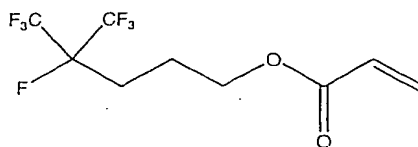


141. The production process of claim 140 wherein the dehalogenating comprises exposing the heterohalogenated alcohol to tributyltin hydride.

142. The production process of claim 140 further comprising reacting the homohalogenated alcohol to form a  $R_F$ -monomer.

143. The production process of claim 142 wherein the reacting comprises exposing the homohalogenated alcohol to an acryloyl compound.

144. The production process of claim 143 wherein:  
the acryloyl compound comprises acryloyl chloride; and



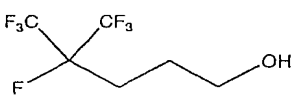
the  $R_F$ -monomer comprises

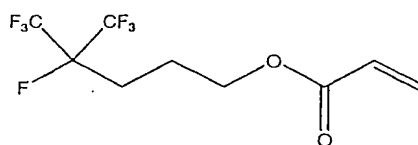
145. A production process comprising reacting an alcohol to form an acrylate,  
5 wherein the alcohol comprises at least one  $(CF_3)_2CF$ - group.

146. The production process of claim 145 wherein the reacting comprises exposing the alcohol to an acryloyl compound.

147. The production process of claim 146 wherein the acryloyl compound comprises acryloyl chloride.

- 10 148. The production process of claim 146 wherein:

the alcohol comprises  ;  
the acryloyl compound comprises acryloyl chloride; and



the  $R_F$ -monomer comprises

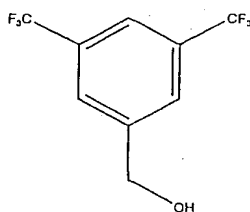
- 15 149. A production process comprising reacting an alcohol to form a  $R_F$ -monomer,  
wherein the alcohol comprises at least two  $-CF_3$  groups and a cyclic group.

150. The production process of claim 149 wherein the reacting comprises exposing the alcohol to an acryloyl compound.

151. The production process of claim 150 wherein the acryloyl compound comprises acryloyl chloride.

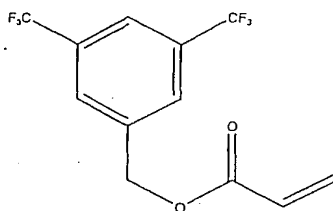


152. The production process of claim 150 wherein:



the alcohol comprises

the acryloyl compound comprises acryloyl chloride; and



the  $R_F$ -monomer comprises

153. A production process comprising reacting an olefin with a saturated compound to form a saturated product, wherein:

the olefin comprises at least two  $-CF_3$  groups; and

the saturated compound comprises at least two other  $-CF_3$  groups; and

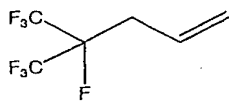
the saturated product comprises both the  $-CF_3$  groups of the olefin and the  $-CF_3$  groups of the saturated compound.

154. The production process of claim 153 wherein:

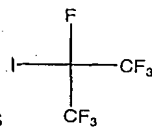
the olefin comprises at least one  $(CF_3)_2CF-$  group; and

the saturated compound comprises at least another  $(CF_3)_2CF-$  group.

155. The production process of claim 153 wherein:

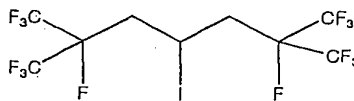


the olefin comprises



the saturated compound comprises

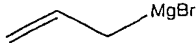
; and

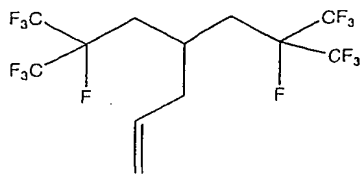


the saturated product comprises

156. The production process of claim 155 further comprising preparing a  $R_F$ -monomer from the saturated product, wherein the preparing comprises reacting the saturated product with an allyl-comprising compound.

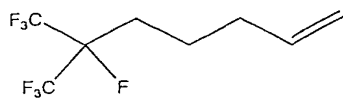
157. The production process of claim 156 wherein:

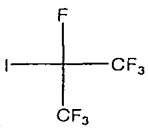
the allyl-comprising compound comprises ; and

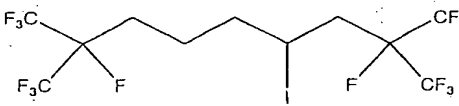


the  $R_F$ -monomer comprises

158. The production process of claim 153 wherein:

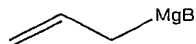
the olefin comprises ;

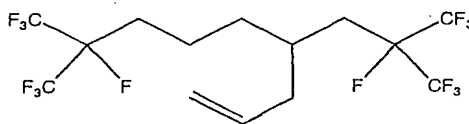
the saturated compound comprises ; and

the saturated product comprises 

159. The production process of claim 158 further comprising preparing a  $R_F$ -monomer from the saturated product, wherein the preparing comprises reacting the saturated product with an allyl-comprising compound.

160. The production process of claim 159 wherein:

the allyl-comprising compound comprises ; and



the  $R_F$ -monomer comprises

161. A production process comprising reacting a first reactant comprising at least two  $-CF_3$  groups with a second reactant comprising a cyclic group to form a compound comprising the two  $-CF_3$  groups and the cyclic group.

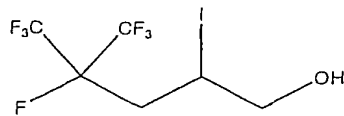
162. The production process of claim 161 wherein the first reactant comprises an alcohol.

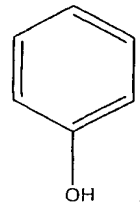
163. The production process of claim 162 wherein the first reactant comprises a heterohalogenated alcohol, wherein the alcohol comprises at least one halogen other than fluorine.

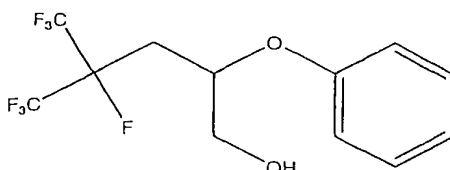
164. The production process of claim 161 wherein the second reactant comprises an alcohol.

165. The production process of claim 161 wherein the cyclic group of the second reactant comprises an aromatic group.

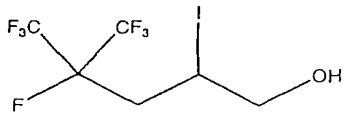
166. The production process of claim 161 wherein:

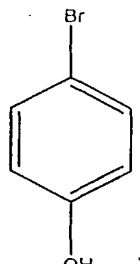
the first reactant comprises  ;

the second reactant comprises  ; and

the compound comprises 

167. The production process of claim 161 wherein:

the first reactant comprises  ;

the second reactant comprises  ; and

the compound comprises 